

jc715 U.S. PTO  
00/62/20

03-01-00

Please type a plus sign (+) inside this box → +

Approved for use through 09/30/2000. OMB 0651-0032

Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

## UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No. 132,424

First Inventor or Application Identifier CHI WANG

Title A Tunable Microwave Multiplexer

Express Mail Label No. EK 486659147 US

### APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1.  Fee Transmittal Form (e.g., PTO/SB/17)  
(Submit an original and a duplicate for fee processing)
2.  Specification [Total Pages 19]
  - Descriptive title of the Invention
  - Cross References to Related Applications
  - Statement Regarding Fed sponsored R & D
  - Reference to Microfiche Appendix
  - Background of the Invention
  - Brief Summary of the Invention
  - Brief Description of the Drawings (if filed)
  - Detailed Description
  - Claim(s)
  - Abstract of the Disclosure
3.  Drawing(s) (35 U.S.C. 113) [Total Sheets 5]
4. Oath or Declaration [Total Pages ]
  - a.  Newly executed (original or copy)
  - b.  Copy from a prior application (37 C.F.R. § 1.63(d))  
(for continuation/divisional with Box 16 completed)
    - i.  DELETION OF INVENTOR(S)  
Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

\* NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

ADDRESS TO: Assistant Commissioner for Patents  
Box Patent Application  
Washington, DC 20231

5.  Microfiche Computer Program (Appendix)
6. Nucleotide and/or Amino Acid Sequence Submission  
(if applicable, all necessary)
  - a.  Computer Readable Copy
  - b.  Paper Copy (identical to computer copy)
  - c.  Statement verifying identity of above copies

### ACCOMPANYING APPLICATION PARTS

7.  Assignment Papers (cover sheet & document(s))
8.  37 C.F.R. § 3.73(b) Statement  Power of  
(when there is an assignee)  Attorney
9.  English Translation Document (if applicable)
10.  Information Disclosure Statement (IDS)/PTO-1449  Copies of IDS  
Statement
11.  Preliminary Amendment
12.  Return Receipt Postcard (MPEP 503)  
(Should be specifically itemized)
13.  Small Entity Statement(s)  Statement filed in prior application,  
(PTO/SB/09-12)  Status still proper and desired
14.  Certified Copy of Priority Document(s)  
(if foreign priority is claimed)
15.  Other: .....

16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:

Continuation  Divisional  Continuation-in-part (CIP) of prior application No: \_\_\_\_\_

Prior application information: Examiner \_\_\_\_\_

Group / Art Unit: \_\_\_\_\_

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

### 17. CORRESPONDENCE ADDRESS

Customer Number or Bar Code Label  (Insert Customer No. or Attach bar code label here) or  Correspondence address below

Name	Larry Moskowitz		
	Alcatel		
Address	1909 K ST., N.W. Suite 800		
City	Washington	State	D.C.
Country	USA	Telephone	202 715 3717 Fax 202 715 3715

Name (Print/Type)	Larry Moskowitz	Registration No. (Attorney/Agent)	42911
Signature		Date	2/29/00

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231.

jc675 U.S. PTO  
09/514879  
02/29/00

IN THE UNITED STATES  
PATENT AND TRADEMARK OFFICE

PATENT APPLICATION FOR  
A TUNABLE MICROWAVE MULTIPLEXER

BY

CHI WANG

I HEREBY CERTIFY THAT this correspondence is being deposited with the United States Postal Service Express Mail (Express Mail Label No. EK 486659147US) with sufficient postage in an envelop addressed to:

Assistant Commissioner for Patents  
Washington, DC 20231

on 29 February, 2000.



John Sideris  
signature

John Sideris  
printed name of person signing certificate

# A TUNABLE MICROWAVE MULTIPLEXER

## FIELD OF THE INVENTION

5       The invention is related to the field of tunable multiplexers. More particularly, this invention relates to a tunable multiplexer which can effectively couple ceramic or metallic resonator filters with TEM resonator filters. The multiplexer provides contiguous channel spacing and wide resonant frequency band tuning.

## 10 BACKGROUND OF THE INVENTION

Multiplexers are used to combine a plurality of channels, each centered at a different frequency, into one combined signal. The same multiplexer can be used to separate a single signal carrying many frequencies or channels into the constituent 15 channels, each channel located at its respective frequency.

In the prior art, multiplexers have been designed by connecting bandpass filters in parallel or series to combine the plurality of channels. Relatively simple decoupling techniques work to separate the constituent channels provided that the channels are separated by frequency spacings equivalent to several passbands of the individual filters. However, when the channels of the multiplexer are too close in frequency, the interaction 20 of the nearby channels will significantly degrade the performance of the multiplexer. Simple decoupling techniques prove ineffective at frequencies this close.

25       When the channels of the multiplexer are contiguous, the multiplexer should be designed as an integral unit. One method of achieving this is disclosed in the paper "A Technique for the Design of a Multiplexer Having Contiguous Channels<sup>1</sup>," hereby incorporated by reference. The channel filters are connected in parallel using high

---

<sup>1</sup> G.L. Matthaei and L. Young, "A Technique for the Design of Multiplexer Having Contiguous Channels," IEEE Trans. Microwave Theory Tech., vol. MTT-12, pp. 88-93, Jan. 1964.

impedance coupling wire. In addition, a susceptance-anulling network using a low-  
impedance line added at the common port results in a nearly constant total input  
admittance. However, it is very difficult to design and manufacture the coupling wires  
needed to achieve the required couplings and low imaginary impedance over all channels  
5 or frequency bands at the common port.

The paper “A Generalized Multiplexer Theory<sup>2</sup>,” hereby incorporated by  
reference, discloses the use of a common transformer to produce planar structure  
duplexers, star shaped combline filters and interdigital multiplexers. However, this  
10 method is limited to use with TEM resonator structures.

U.S. Patent No. 5,262,742, hereby incorporated by reference, discloses a half  
wavelength transmission line used as a common resonator or common transformer. The  
common resonator is used to couple two combline filters to a common antenna port.  
15 However, like the method disclosed in “A Generalized Multiplexer Theory,” this method  
is limited to use with TEM resonator structures.

## SUMMARY OF THE INVENTION

20 Referring now to the figures, in which like numerals refer to like elements, the  
present invention is shown. The invention comprises a tunable microwave multiplexer.  
Within the multiplexer is a plurality of channel filters comprising at least one resonator  
for filtering microwave and RF signals. The channel filters are coupled to a  
combining/dividing mechanism. The combining/dividing mechanism comprises a  
25 common port and a common resonator coupled to the common port.

In another embodiment, the invention comprises a microwave communication  
system comprising a receiver for receiving RF and microwave signals, a transmitter for  
transmitting RF and microwave signals, a signal processor coupled to the receiver and  
30 transmitter for processing signals and at least one antenna coupled to the receiver and the

---

<sup>2</sup> J.D. Rhodes and R. Levy, IEEE Trans. Microwave Theory Tech., vol. MTT-27, pp. 111-123, Feb. 1979.

transmitter. Either the receiver or the transmitter can comprise a tunable microwave multiplexer. The tunable microwave multiplexer comprises a plurality of channel filters comprising at least one resonator for filtering RF and microwave signals. In addition, the multiplexer contains a combining/dividing mechanism coupled to the plurality of channel filters via coupling apertures. The combining/dividing mechanism comprises a common port and a multiple half-wavelength coaxial resonator coupled to the common port. In addition, the tunable microwave multiplexer contains transmission ports coupled to the plurality of filters.

In still another embodiment, the invention comprises a method of multiplexing a plurality of microwave channel frequencies. This method includes the steps of inputting a signal comprising a plurality of frequency channels into a common resonator. In addition, the phase difference between a common port of a common resonator to each RF port of a plurality of cavity channel filters is maintained at approximately 0 or 180 degrees. Furthermore, the signal comprising a plurality of frequency channels is separated into its constituent frequency signals. Still furthermore, at least one of said plurality of frequency channels is output.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a configuration of a 4-channel tunable multiplexer, according to one embodiment of the present invention.

Fig. 2 is a configuration of a common resonator, according to one embodiment of the present invention.

Fig. 3 is a measured frequency response of a 4-channel tunable multiplexer, according to one embodiment of the present invention.

Fig. 4 is drawing of the tunable multiplexer housing, according to one embodiment of the present invention.

Fig. 5 is a circuit diagram of a 4-channel tunable multiplexer using a common resonator, according to one embodiment of the present invention.

## 5 DETAILED DESCRIPTION OF ONE EMBODIMENT OF THE INVENTION

Referring now to the figures, in which like numerals refer to like elements, the present invention is shown. The present invention consists of a tunable microwave multiplexer 1 comprising a plurality of channel filters 2-8 coupled to a combining/dividing mechanism. In a preferred embodiment, the plurality of channel filters 2-8 can be either dielectric loaded resonators or combine resonators, while the combining/dividing mechanism is preferably a common resonator 20.

The tunable microwave multiplexer 1 can be used in a microwave communication system that both receives and transmits RF and microwave signals. The tunable microwave multiplexer can be used to both multiplex and demultiplex RF and microwave signals. An example of a microwave communication system that can be used is found in Patent No. 4,578,815, hereby incorporated by reference.

The tunable multiplexer 1 operates in the following manner. A signal comprising a plurality of microwave signal frequencies is input at a common port 10. The signal will pass through the common resonator 20. A signal frequency from one of the plurality of microwave signals will couple into a filter 2-8 if the passband of the filter is tuned to the frequency of the microwave signal. On the other hand, if the passband of the filter is tuned to a different frequency, then the filter 2-8 will reject the microwave signal. In this manner, the plurality of microwave signals will be separated.

The tunable multiplexer 1 can also be used to combine signals of different frequencies. Signals of different frequencies are input via transmission ports to a channel filter 2-8 that will pass its respective frequency. The signals will be combined into one

signal comprising these different signal frequencies in the common resonator 20. The composite signal is then output through the common port 20.

## **Multiplexer**

5

The tunable microwave multiplexer 1 has a common port 10 into which a signal comprising a plurality of microwave signal frequencies is input. In a preferred embodiment, the common port 10 can be a single coaxial cable connector (see Fig. 1). The common port 10 can be coupled to the common resonator 20 using a tapped-in or  
10 loop configuration.

Use of a common resonator combining/dividing structure for the multiplexer 1 can maintain the phase difference of the RF signal from the common port 10 of the common resonator 20 to each RF port of the cavity channel filters 2-8 at precisely 0 or  
15 180 degrees. Thus, there is no phase difference or displacement where the channel filters 2-8 interface with the common resonator 20. Therefore, no critical phasing transmission line is needed in the multiplexer 1. As a result, microwave channel frequencies can be combined or divided efficiently over a broad bandwidth.

## **20 Half-Wavelength Coaxial Resonator**

In a preferred embodiment, the common resonator is a multiple half-wavelength coaxial resonator 20 (see Fig. 1). The coaxial resonator's length is a multiple half-wavelength of the average frequency of the multiplexer 1. Stated another way, the  
25 physical length of the coaxial resonator 20 is a multiple half-wavelength of the average frequency of the input signal comprising a plurality of microwave signal frequencies input at common port 10. Therefore, the coaxial resonator 20 appears as a low impedance to any of the input channel frequencies.

30 The coaxial resonator 20 is operated at a higher order TEM mode. Thus, either the magnetic field or the electric current is a maximum at both ends of the resonator 20.

In addition, there is a quarter wavelength difference in phase between the electric and the magnetic fields. Consequently, when the magnetic field is a minimum, the electric field is a maximum and vice-versa.

5 An adjustment screw SC1 (accessible from the outside of the enclosure of the coaxial resonator 20) is used to adjust the resonant frequency of the coaxial resonator 20 (see Fig. 2). It is positioned where the electric field is a maximum in the coaxial resonator 20. By changing the resonant frequency of the coaxial resonator 20, a new center frequency is selected.

10

In a preferred embodiment, the coaxial resonator 20 comprises an enclosure E1, a cavity 28 and an inner conductor C1 (see Fig. 2). The inner conductor C1 is either milled into the resonator cavity 28 or affixed into the cavity 28 using the same conductive material as that used for the resonator's 20 enclosure E1. This ensures that the

15

conductive material maintains good contact over temperature.

20

Both the magnetic and the electric fields vary periodically every half-wavelength along the half-wavelength coaxial resonator 20. Thus, there are multiple maximum magnetic field positions distributed along the resonator 20. Coupling apertures 60, 62, 64 and 66 (see Fig. 1 and Fig. 2) located on the enclosure wall EW1 of the common resonator 20, are positioned at the peaks of the magnetic field respectively. The signal input to the common port 10 is radiated through these coupling apertures 60-66. In a preferred embodiment, four channel filters 2, 4, 6 and 8 (see Fig. 1) are coupled to the coupling apertures 60 through 66 of the coaxial resonator 20 respectively. This allows

25

for efficient coupling of the channel filters to the common port 10 of the multiplexer/demultiplexer 1 and optimized compactness of the housing.

## Channel Filters

30

In a preferred embodiment, the plurality of channel filters 2-8 can consist of either dielectric loaded resonators or combline resonators. In a preferred embodiment, the

dielectric loaded resonators can be made from a ceramic material. In another preferred embodiment, the combline resonators can be made from a ceramic material. In still another preferred embodiment, the combline resonators can be metallic resonators.

5 Fig. 1 discloses a preferred embodiment of the tunable microwave multiplexer/demultiplexer 1 that contains four filters 2, 4, 6 and 8, connected in parallel. In a preferred embodiment, each channel filter comprises two resonators, 32, 34, 36, 38, 10 40, 42, 44 and 46 (for a total of eight resonators) which are located in two cavities, 12, 14, 16, 18, 20, 22, 24 and 26 (for a total of eight cavities), respectively. For example, filter 2 comprises resonators 32 and 34 located in cavities 12 and 14 respectively. The two resonators 32 and 34 are connected in series.

15 The individual resonators 32-46 may be regarded as filter sections. An increase in the number of resonators 32-46 (or filter sections) connected in series produces a steeper skirt on the passband of the respective filter 2-8 which results in sharper attenuation of undesired frequencies. It should be noted that while four filters 2-8 containing two resonators 32-46 are shown, any number and combination of filters and resonators may also be used in accordance with what the specification discloses. Fig. 3 is an exemplary plot of the measured frequency response of a 4-channel tunable multiplexer 1.

20 The cavities 12-26 are located within a housing 3 (see Fig. 1 and Fig. 4). In a preferred embodiment, the housing 3 is made from a conductive material such as aluminum, although other metals will also work well. In addition, a common enclosure wall 5 separates the cavities 12 through 26. Fig. 1 shows that the two resonators 32-46 of 25 each channel filter, 2, 4, 6 and 8, are coupled together by apertures 50, 52, 54 and 56 respectively, opened on the common enclosure wall 5 between the two resonators.

30 In a preferred embodiment, the dielectric resonator used is disclosed in copending U.S. patent application 60/155,600, Tunable, Temperature Stable Dielectric Loaded Cavity Resonator and Filter, hereby incorporated by reference. In a preferred

embodiment, the filters are tunable. A tuning element assembly can be used to adjust the frequency.

As stated above, the amount of coupling between the channel filters 2-8 and the common port 10 of the multiplexer 1 is controlled by the size and the location of the coupling apertures, 60 through 66. Energy from the multiple half-wavelength coaxial resonator 20 is coupled through the coupling apertures 60 through 66 and into the filters (2, 4, 6 and 8 respectively) via the filter resonator 32-44 connected to that aperture 60-66, respectively. The other end of each filter not connected to the coupling apertures is connected to a transmission port. Transmission ports TX1 through TX4 are connected to filters 2, 4, 6 and 8 respectively (see Fig. 1). In a preferred embodiment, transmission ports TX1 through TX4 can each be a single coaxial cable connector (see Fig. 1). Each transmission port TX1-TX4 can be used to output one of the channel frequencies separated by the tunable multiplexer 1. In addition, it can be used as an input to receive a single channel frequency which will be combined in coaxial resonator 20 with other received channel frequencies from other transmission ports TX1-TX4 and output through common port 10.

## Circuit Diagram

Fig. 5 is a circuit diagram of a 4-channel tunable multiplexer 1, according to one embodiment of the present invention. Electrical circuit 100 illustrates schematically the circuit formed by the half-wavelength common resonator 20 and four channel filters 2-8 of Fig. 1. Transformer M\_com represents common port 10. Transformers M01\_1 through M01\_4 represent the coupling apertures 60 – 66 located on the enclosure walls E1 of the common resonator 20. Transformers M12\_1 through M12\_4 represent apertures 50 – 56 opened on the common enclosure wall between the two resonators through which the two resonators of each channel filter 2-8 are coupled together, respectively. Transformers M23\_1 to M23\_4 represent transmitting ports TX1 through TX4, respectively.

Parallel RC circuits R\_com and C\_com represent the equivalent electrical circuit for the common resonator 20. Parallel RC circuits R1\_1 and C1\_1 through R2\_4 and C2\_4 represent the equivalent electrical circuits for resonators 32 through 46. Each resonator is tuned to resonate at the frequency meant to be passed by its associated filter.

5 Therefore, it will have a minimum impedance at that frequency. Both contiguous and noncontiguous channel filters 2-8 can be multiplexed/demultiplexed by adjusting the common resonator 20 and channel filter frequencies respectively.

While the invention has been disclosed in this patent application by reference to  
10 the details of preferred embodiments of the invention, it is to be understood that the disclosure is intended in an illustrative, rather than a limiting sense, as it is contemplated that modifications will readily occur to those skilled in the art, within the spirit of the invention and the scope of the appended claims and their equivalents.

## CLAIMS

What is claimed is:

1. A tunable microwave multiplexer, comprising:
  - a plurality of channel filters comprising at least one resonator; and
  - a combining/dividing mechanism coupled to said plurality of channel filters comprising:
    - a common port; and
    - a common resonator coupled to said common port.
2. The tunable microwave multiplexer according to claim 1, wherein said at least one resonator is a combline resonator.
3. The tunable microwave multiplexer according to claim 1, wherein said at least one resonator is a dielectric loaded resonator.
4. The tunable microwave multiplexer according to claim 1, wherein said at least one resonator is a ceramic resonator.
5. The tunable microwave multiplexer according to claim 1, wherein said at least one resonator is a metallic resonator.
6. The tunable microwave multiplexer according to claim 1, further comprising transmission ports coupled to said plurality of filters.
7. The tunable microwave multiplexer according to claim 1, wherein at least one of said plurality of said channel filters comprises more than one filter section.

8. The tunable microwave multiplexer according to claim 1, wherein said at least one resonator comprises a tuning element assembly, whereby a resonant frequency can be adjusted.
9. The tunable microwave multiplexer according to claim 1, wherein said common resonator is a coaxial resonator.
10. The tunable microwave multiplexer according to claim 1, wherein said common port is coupled to said common resonator using a tapped-in or loop configuration.
11. The tunable microwave multiplexer according to claim 1, wherein said common resonator further comprises coupling apertures, wherein said plurality of channel filters is coupled to said plurality of coupling apertures.
12. The tunable microwave multiplexer according to claim 1, wherein said common resonator comprises an adjustment screw, whereby said adjustment screw is used to adjust the resonant frequency of said common resonator.
13. The tunable microwave multiplexer according to claim 1, wherein said common resonator comprises:
- an enclosure;
  - a cavity positioned inside said enclosure; and
  - an inner conductor positioned in said cavity.
14. The tunable microwave multiplexer according to claim 1, wherein said more than one resonator is connected in series with at least one other resonator.
15. The tunable microwave multiplexer according to claim 7, wherein said more than one filter section is connected in series with at least one other filter section.

16. The tunable microwave multiplexer according to claim 9, wherein said coaxial resonator is a multiple half-wavelength coaxial resonator.
17. The tunable microwave multiplexer according to claim 11, wherein said coupling apertures are positioned at peaks of a magnetic field.
18. The tunable microwave multiplexer according to claim 12, wherein said adjustment screw is positioned where the electric field is a maximum in said common resonator.
19. The tunable microwave multiplexer according to claim 13, wherein said inner conductor is milled into said cavity.
20. The tunable microwave multiplexer according to claim 13, wherein said inner conductor is affixed into said cavity.
21. The tunable microwave multiplexer according to claim 13, wherein said inner conductor is made using the same conductive material as that used for the common resonator's enclosure.
22. A tunable microwave multiplexer, comprising:
- a plurality of channel filters comprising at least one resonator; and
  - a combining/dividing mechanism coupled to said plurality of channel filters via coupling apertures, comprising:
    - a common port, and
    - a multiple half-wavelength coaxial resonator coupled to said common port; and
  - transmission ports coupled to said plurality of filters.

23. The tunable microwave multiplexer according to claim 22, wherein said coupling apertures located on said enclosure wall of said common resonator are positioned at peaks of a magnetic field.
24. The tunable microwave multiplexer according to claim 22, wherein said common port is coupled to said common resonator using a tapped-in or loop configuration.
25. The tunable microwave multiplexer according to claim 22, wherein said at least one resonator is a combline resonator.
26. The tunable microwave multiplexer according to claim 22, wherein said at least one resonator is a dielectric loaded resonator.
27. The tunable microwave multiplexer according to claim 22, wherein said at least one resonator is a ceramic resonator.
28. The tunable microwave multiplexer according to claim 22, wherein said at least one resonator is a metallic resonator.
29. The tunable microwave multiplexer according to claim 22, wherein said at least one resonator comprises a tuning element assembly, whereby a resonant frequency can be adjusted.
30. The tunable microwave multiplexer according to claim 22, wherein said multiple half-wavelength coaxial resonator comprises:
- an enclosure;
  - a cavity positioned inside said enclosure; and
  - an inner conductor positioned in said cavity.

31. The tunable microwave multiplexer according to claim 22, wherein said at least one resonator is connected in series with at least one other resonator.
32. The tunable microwave multiplexer according to claim 22, wherein said inner conductor is milled into said cavity.
33. The tunable microwave multiplexer according to claim 22, wherein said inner conductor is affixed into said cavity.
34. The tunable microwave multiplexer according to claim 22, wherein said multiple half-wavelength coaxial resonator comprises an adjustment screw, whereby said adjustment screw is used to adjust the resonant frequency of said multiple half-wavelength coaxial resonator, wherein said adjustment screw is positioned where the electric field is a maximum in said common resonator.
35. A microwave communication system, comprising:
- a receiver;
  - a signal processor coupled to said receiver; and
  - at least one antenna coupled to said receiver;
- wherein said receiver comprises at least one tunable microwave multiplexer, comprising:
- a plurality of channel filters comprising at least one resonator; and
  - a combining/dividing mechanism coupled to said plurality of channel, comprising:
    - a common port, and
    - a multiple half-wavelength coaxial resonator coupled to said common port; and

transmission ports coupled to said plurality of filters.

36. The tunable microwave multiplexer according to claim 35, further comprising coupling apertures coupling said combining/dividing mechanism and

said plurality of channel filters, wherein said coupling apertures are located on said enclosure wall of said common resonator, positioned at peaks of a magnetic field.

37. The tunable microwave multiplexer according to claim 35, wherein said common port is coupled to said common resonator using a tapped-in or loop configuration.

38. The tunable microwave multiplexer according to claim 35, wherein said at least one resonator comprises a tuning element assembly, whereby a resonant frequency can be adjusted.

39. The tunable microwave multiplexer according to claim 35, wherein said multiple half-wavelength coaxial resonator comprises:

- an enclosure;
- a cavity positioned inside said enclosure; and
- an inner conductor positioned in said cavity.

40. The tunable microwave multiplexer according to claim 35, wherein said at least one resonator is connected in series with at least one other resonator.

41. The tunable microwave multiplexer according to claim 35, wherein said multiple half-wavelength coaxial resonator comprises an adjustment screw, whereby said adjustment screw is used to adjust the resonant frequency of said common resonator, wherein said adjustment screw is positioned where the electric field is a maximum in said common resonator.

42. A microwave communication system, comprising:

- a transmitter;
- a signal processor coupled to said transmitter; and
- at least one antenna coupled to said transmitter;

wherein said transmitter comprises at least one tunable microwave multiplexer, comprising:

a plurality of channel filters comprising at least one resonator; and

a combining/dividing mechanism coupled to said plurality of channel filters, comprising:

a common port, and

a multiple half-wavelength coaxial resonator coupled to said common port; and

transmission ports coupled to said plurality of filters.

43. The tunable microwave multiplexer according to claim 42, further comprising coupling apertures for coupling said combining/dividing mechanism and said plurality of channel filters, wherein said coupling apertures are located on said enclosure wall of said common resonator, positioned at peaks of a magnetic field.

44. The tunable microwave multiplexer according to claim 42, wherein said common port is coupled to said common resonator using a tapped-in or loop configuration.

45. The tunable microwave multiplexer according to claim 42, wherein said at least one resonator comprises a tuning element assembly, whereby a resonant frequency can be adjusted.

46. The tunable microwave multiplexer according to claim 42, wherein said multiple half-wavelength coaxial resonator comprises:  
an enclosure;  
a cavity positioned inside said enclosure; and  
an inner conductor positioned in said cavity.

47. The tunable microwave multiplexer according to claim 42, wherein said at least one resonator is connected in series with at least one other resonator.
48. The tunable microwave multiplexer according to claim 42, wherein said multiple half-wavelength coaxial resonator comprises an adjustment screw, whereby said adjustment screw is used to adjust the resonant frequency of said common resonator, wherein said adjustment screw is positioned where the electric field is a maximum in said common resonator.
49. A method of multiplexing a plurality microwave channel frequencies, comprising:
- inputting a signal comprising a plurality of frequency channels into a common resonator;
  - maintaining the phase difference between a common port of a common resonator to each RF port of a plurality of cavity channel filters at approximately 0 or 180 degrees;
  - separating said signal comprising a plurality of frequency channels; and
  - outputting at least one of said plurality of frequency channels.
50. The method of multiplexing microwave channel frequencies according to claim 49, wherein said step of separating said signal, comprises:
- coupling said signal comprising a plurality of frequency channels at peaks of a magnetic field within said common resonator to a plurality of channel filters; and
  - filtering the frequency channels of said signal using said plurality of channel filters.
51. The method of multiplexing channel frequencies according to claim 49, further comprising the step of adjusting the resonant frequency of said common resonator.

52. The method of multiplexing channel frequencies according to claim 49,  
further comprising the step of adjusting the resonant frequency of one of said  
plurality of frequency channels.
53. The method of multiplexing channel frequencies according to claim 49,  
wherein said common resonator is a multiple half-wave coaxial resonator.

## ABSTRACT OF THE DISCLOSURE

The invention is related to the field of tunable multiplexers. It consists of a tunable microwave multiplexer comprising a plurality of channel filters coupled to a combining/dividing mechanism. The plurality of channel filters can be either dielectric loaded resonators or combline resonators, while the combining/dividing mechanism can be a common resonator. In one embodiment, the common resonator is a multiple half-wavelength coaxial resonator.

Fig. 1 Configuration of a 4-channel tunable multiplexer

5  
4  
3  
2  
1

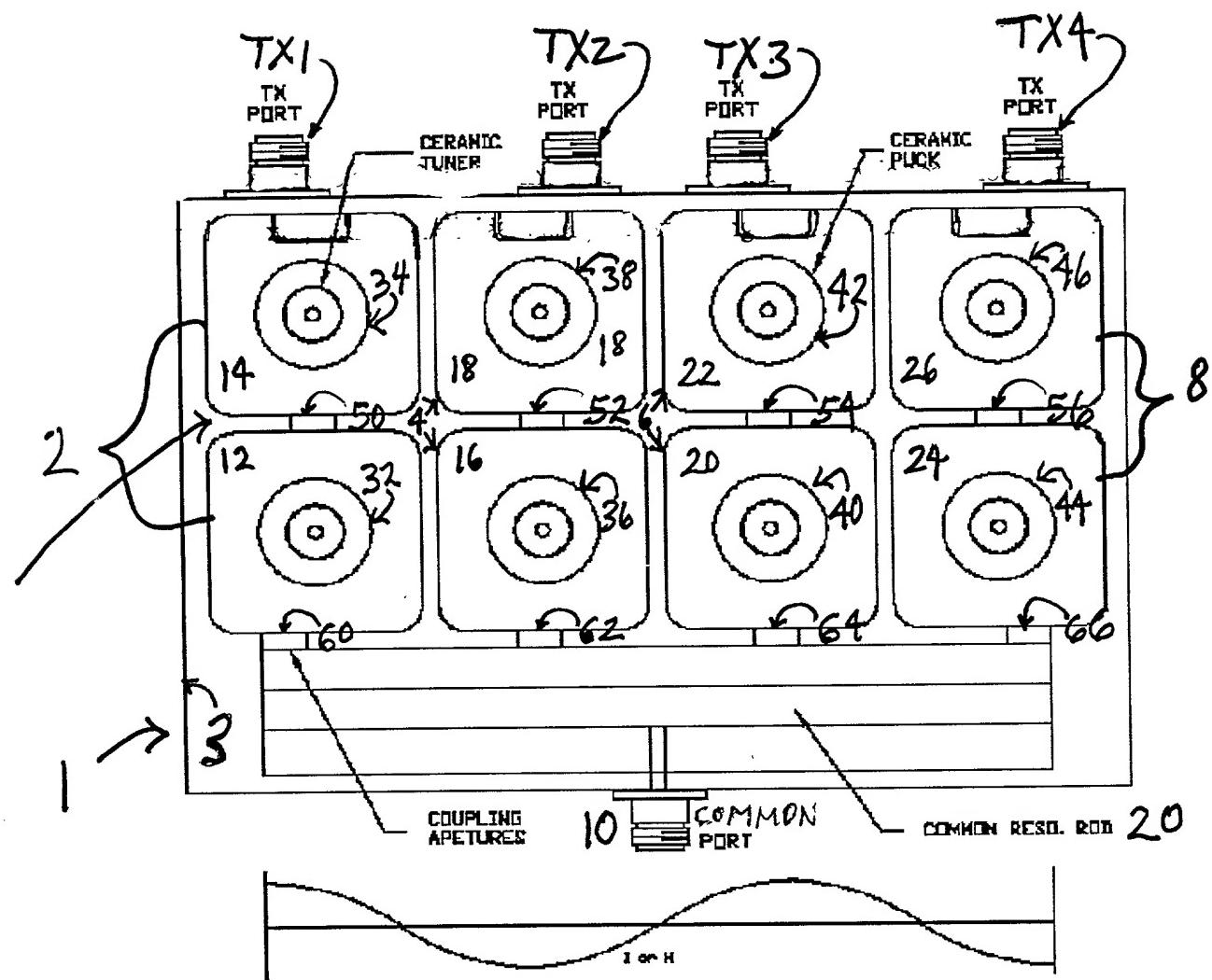
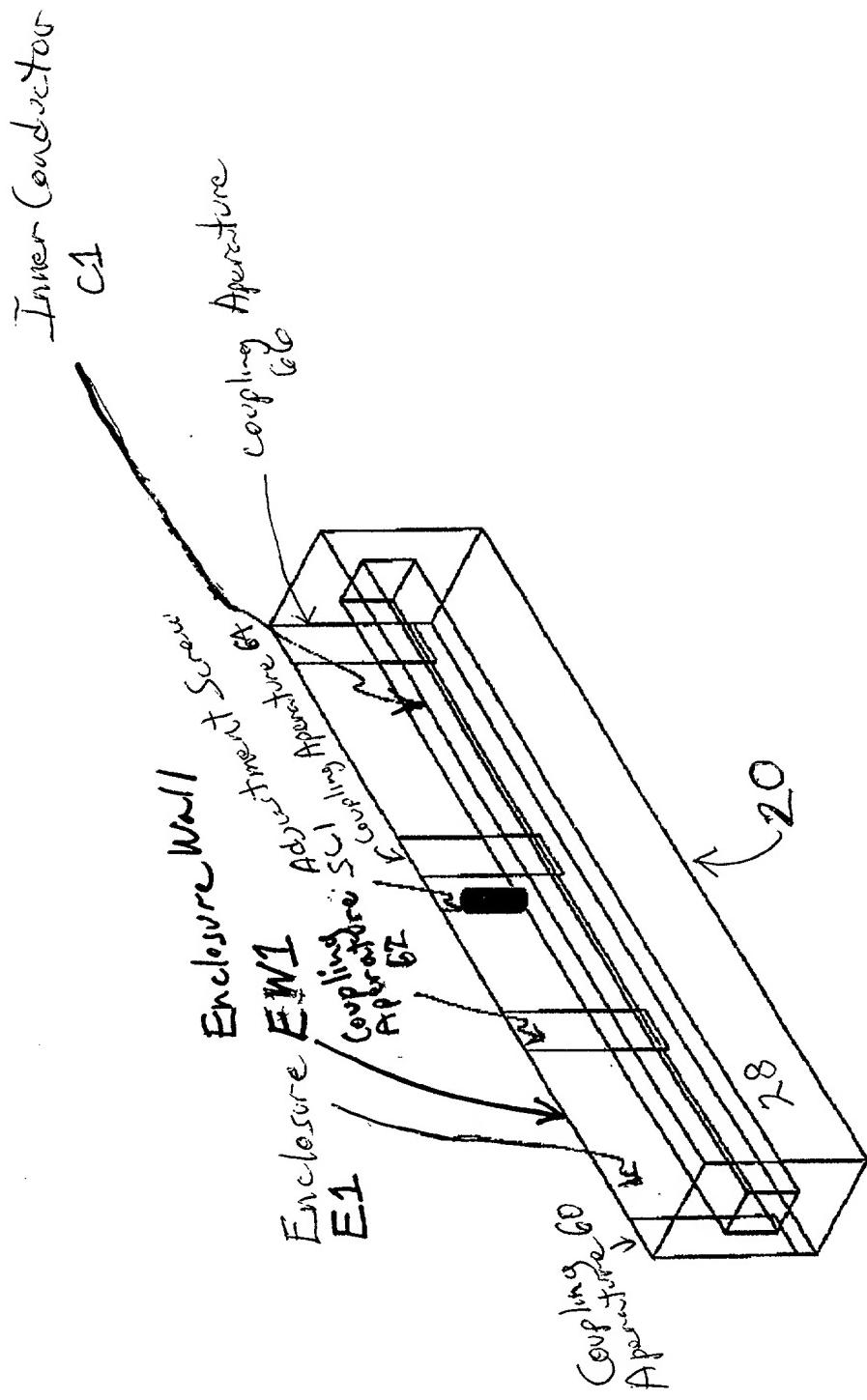


Fig 2: Configuration of a Common Resonator



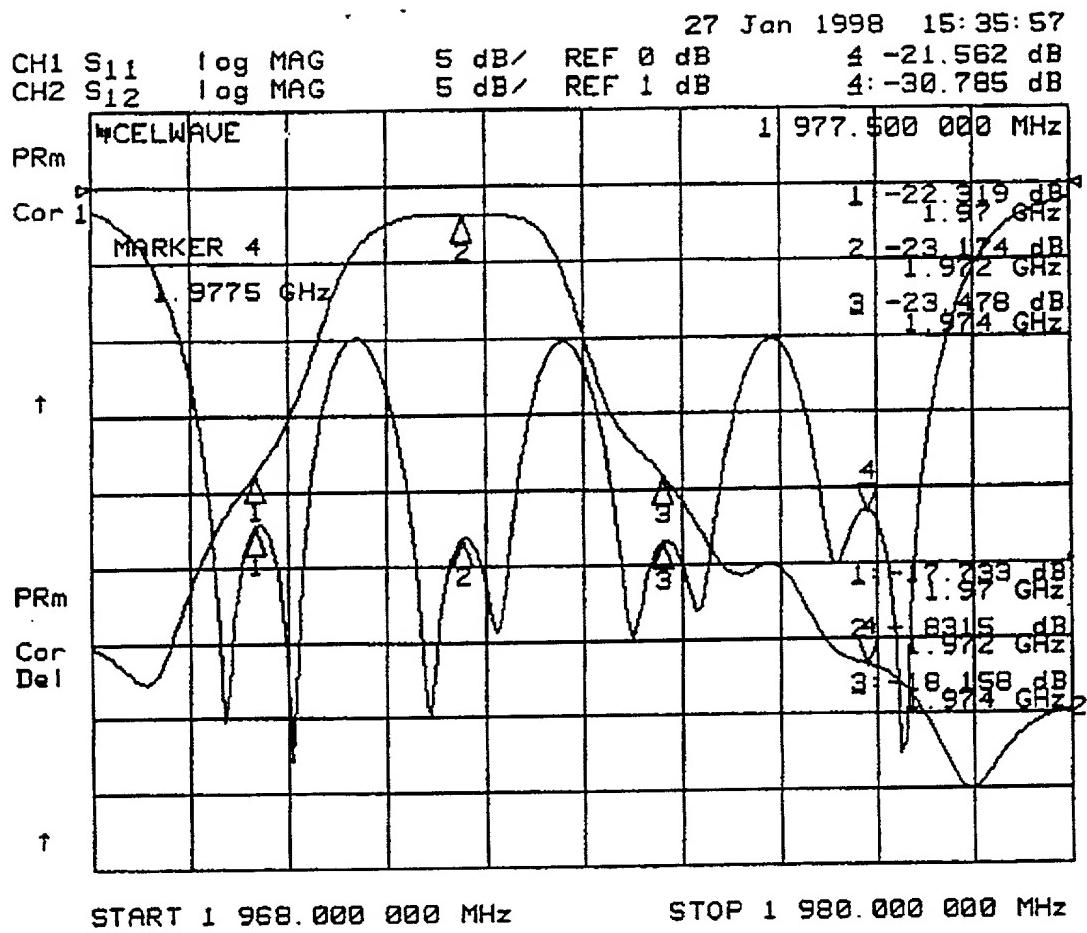


Fig. 3 Measured frequency responses of the 4-channel multiplexer.

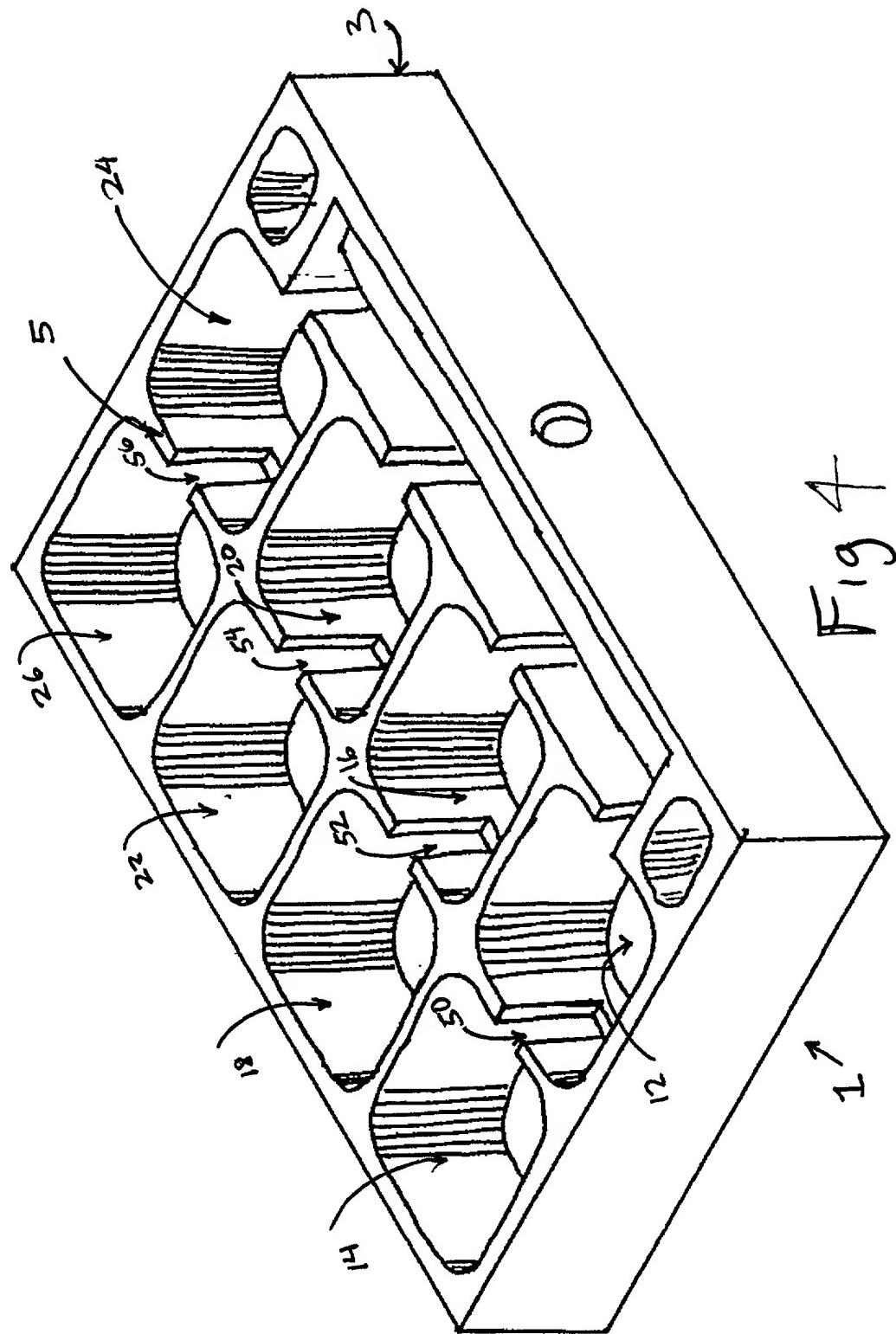


Fig 4

100

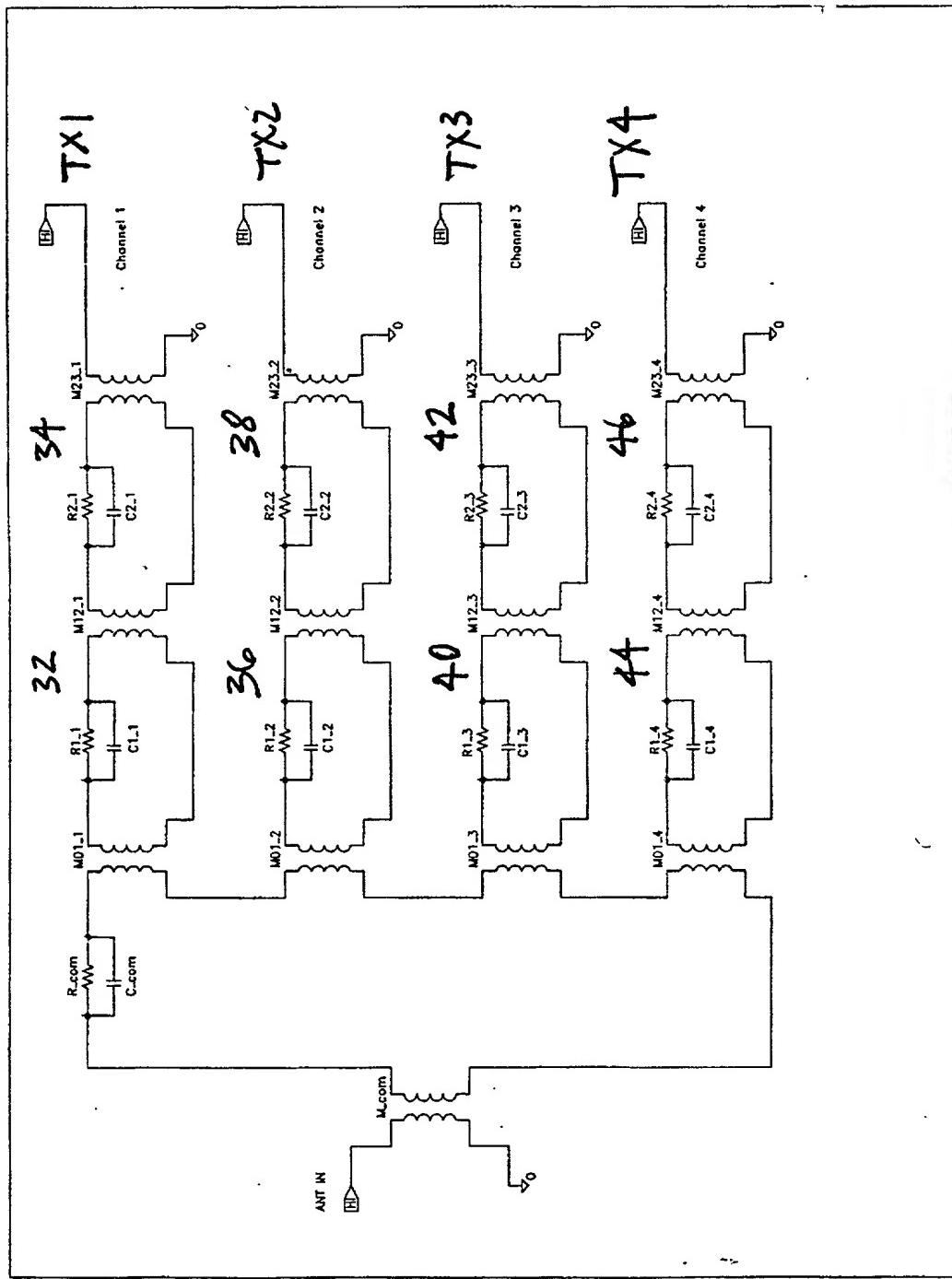


Fig. 5 Circuit diagram of a 4-channel multiplexer using common resonator